American and Colonial, which are again sub-divided into alphabetical and classified sections; in the case of the British, a Geographical Section has been added, making in all nine sub-divisions.

Photography as a Hobby. "The Popular Photographic Series." By Matthew Surface. Pp. 60. (London: Percy Lund, Humphries, and Co., Ltd., 1897.)

This little book is intended for those who amuse themselves with photography. The author shows how many a pleasant hour may be spent with the camera, and describes rambles he himself has made. These are very well illustrated, and the reader will gather from them that it is not necessary to go very far afield for subjects, as these are always close at hand if one only has the capacity for picking them out. The author describes also how, during unfavourable weather, the "hobby" may be carried on in the house. The book is very neatly got up, and will afford those who indulge in photography as a hobby with a pleasant hour's reading.

First Records of British Flowering Plants. Compiled by William A. Clarke, F.L.S. Pp. 103. (London: West, Newman, and Co., 1897.)

To satisfy commendable curiosity, it is often required to know who first observed a particular plant, when and where it was first found, and how long it has been known as a British plant. The answers to these questions will be found in Mr. Clarke's handy little volume. The earliest notice of each distinct species of British flowering plants has been found by searching through printed botanical works published in Great Britain, and the extracts thus obtained have been brought together in this work. The list contains altogether 1440 species, the nomenclature of which is based upon the eighth edition of the "London Catalogue." The earliest records referred to are from William Turner's works, ranging from 1538 to 1568.

On Human Nature. By Arthur Schopenhauer. Translated by T. Bailey Saunders, M.A. Pp. 132. (London: Swan Sonnenschein and Co., Ltd., 1897.)

Human nature as understood by that most pessimistic of philosophers, Schopenhauer, is here presented in English dress by Mr. Saunders. The essays which make up the book have been selected and translated from Schopenhauer's *Parerga.* They deal with human nature in various aspects, and their tendency is to make a man suspicious of all people, distrustful of all motives, and doubtful whether civilised life is real or only a big masquerade.

Tabellen für Gasanalysen, gasvolumetrische Analysen, Stickstoffbestimmungen, &c. By Prof. Dr. G. Lunge. (Braunschweig: Friedrich Vieweg und Sohn, 1897.)

These tables will be found of service in chemical laboratories in which gas analyses, and volumetric determination of gases, are made. One of the tables is for the reduction of the observed volume of a gas to the temperature of 0°, and the other enables the observed volume to be reduced to a pressure of 760 mm. Together the tables thus furnish the means for reducing volumes of gases to standard temperature and pressure.

The Larvæ of the British Butterflies and Moths. By the late William Buckler. Vol. vii. Edited by Geo. T. Porritt, F.L.S. Pp. 176. 22 plates. (London: Ray Society, 1897.)

The first volume on the larvæ of the British butterflies and moths appeared in 1885; the present volume contains the first portion of the Geometræ, and this group will be completed in vol. viii. The twenty plates illustrating the larvæ described are extremely fine, and the whole volume is a worthy addition to an invaluable series.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

The Measurement of Pressures in the Bore of Guns.

It has been stated that many gunpowders which have given fairly satisfactory results in a small bore, have developed dangerous pressure when tried in cannon; and also that similar experiments with cordite showed no signs of any approach to such a "critical point." Further, cordite is said to burn quietly when thrown in boxes of 100 lbs. upon a bonfire, and yet to be as suitable for ordnance as for small arms. But cordite did not prove so tractable on its late trial in Plumstead Marshes. It is plain, therefore, that explosive forces of all powders depend very much upon the conditions under which they are ignited.

Hence arises a pressing necessity for some satisfactory method of determining the maximum explosive force which every adopted powder is capable of exerting when fired in *rifled* guns of small and large calibre. The chronoscopic method of solving the problem was brought forward thirty years ago, under the then Ordnance Select Committee, but I have never met with a single example fairly worked out for a *rifled* gun, so as to show precisely what could be found by that method. My difficulty was stated in Nature (March 14, 1895), but hitherto without result, except that the President of the British Association, in his address at Ipswich (September 1895), stated that—

"In the gun, by means of electrical contacts arranged in the bore, a *time-curve* of the passage of the shot can be determined. From this the mathematician constructs the velocity-curve, and from this, again, the *pressures* producing the velocity are *estimated* (?) and used to check the *same indications* obtained by other means (p. 29)."

Now, beside the "pressures producing the velocity" of the shot in *rifled* guns, there is an additional force arising from friction, &c., which greatly adds to the pressure of the powder gas tending to burst the gun. Hence, if we denote by P this pressure of the powder gas on the base of the shot, and by F the retarding pressure of friction, &c., at the same instant, then the resultant driving pressure acting on the shot will be denoted by $(P - F)$ at that instant. If now the projectile be made to trace an *accurate* time-curve, it will be possible to deduce from this time-curve the value of the driving pressure $(P - F)$ acting on the shot at every point. But the grand object is to find P, the pressure of the powder gas tending to burst the gun, and not $(P - F)$ the pressure driving the shot, which is given by the chronoscope. Therefore the chronoscopic method of experimenting fails to give the whole pressure of the powder gas, which tends to burst the *rifled* gun; and this method gives nothing which can be "used to check the same indications obtained by other means," simply because $(P - F)$ is not given by other means. The chronoscopic method of experimenting fails when any part of the pressure (F) of the powder gas is not instrumental in producing motion. From what has been said, the chronoscopic method must fail, even under the most favourable circumstances, when *rifled* guns are used.

But the *perfect accuracy* in experiment we have assumed cannot be secured practically. The most critical point is at the instant the shot begins to move. But no chronoscope which registers by *points* can make the smallest pretence to give the initial time-curve accurately.

The only way to find the pressure of the powder gas at any point in the bore of a *rifled* gun is to use a modification of Rumford's or Rodman's method, which measures directly the pressure in the bore at any point.

The vast importance of this subject to the nation at this time must be my excuse for troubling you a second time.

Minting Vicarage, March 4. F. Bashforth.

A Powerful and Efficient Means of Driving X-Ray Tubes.

During the last few months the limitations of the present induction coil, especially as a means of driving X-ray tubes and vacuum tubes in general, have been so clearly brought before us that we have given the subject considerable attention. It is

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true that with some of the new forms of circuit breakers and storage batteries, an induction coil can be made to work fairly well during prolonged runs; but storage batteries are troublesome, and a break that will work on voltages ordinarily supplied for lighting is yet to be made.

The following method of driving an induction coil not only does away with its former disadvantages, but gives a much more powerful means of exciting X-ray tubes. A condenser of considerable capacity is first charged by connecting its terminals to the ordinary lighting mains; it is then disconnected, and discharged through the primary of an induction coil. Any good induction coil can be used in this way with a single change, viz. a new primary. The primary should be a few turns of heavy wire on a finely laminated core.

A six-inch Ritchie vertical coil with a new primary winding of about thirty turns of heavy wire (6 B.S. gauge) gives, when a condenser of 27 micro-farads charged at 220 volts is discharged through its primary, a long thin zig-zag spark, resembling that from a static machine with small condensers. If now some form of rotary commutator be used to charge and discharge the condensers, and this be run at sufficient speed, a continuous discharge of sparks will take the place of the single discharge at the secondary terminals.

The commutator used has six segments. If this is run at 2000 revolutions per minute by a small fan motor, there will be 12,000 discharges through the coil per minute, or 200 per second. At this speed there is a continuous discharge of zig-zag sparks a little over six inches long. We have not yet run the commutator above 2000 revolutions, but there is no indication that we are near the limit of speed. Sparking on the commutator is slight, and the power taken from the mains is but a few ampères.

It is necessary to have the primary of the coil well insulated, not only from the secondary, but its own turns must be well insulated from one another and the core. An easy and effectual way in the case of a vertical coil is to place the laminated core in a glass tube, upon this wind the primary, then place the whole in a large heavy tube closed at the bottom, and fill with oil. Without insulation there is a tremendous brush discharge within the primary. Undoubtedly the efficiency of the coil would be considerably increased by using an oil insulated secondary, but it is questionable whether the gain would be enough to off-set the trouble and dirt of oil insulation.

An X-ray tube of the focus type and proper resistance connected to the terminals of the coil lights up brilliantly, and with a spark gap in series, the length of which seems to make very little difference, shows no indication whatever of anything but a unidirectional discharge through the tube.

Fluorescent screens become brilliantly illuminated. In a darkened room all the bones of the hand and forearm can be distinctly seen on a calcium tungstate screen at a distance of eight feet from the tube. The penetration seems to be unusually strong. The whole of the trunk can be examined with the greatest ease with the tube several feet distant. The hand can be distinctly seen through the abdomen, the most opaque part of the body.

Photographically, X-rays obtained in this way are no less powerful. Excellent fully-timed photographs of the hand can be taken in twenty-five seconds with the tube twelve inches from the plate, photographs not merely showing the outline of the bones, but showing the details of the bones, the finger-nails, tendons, &c. Forty-five seconds is an over-exposure. One of the best photographs of a small object—a pocket-book—we have seen, was taken in less than a second.

It seems apparent that we have a simple method for exciting X-ray tubes that is far more powerful and efficient than any that has yet been used. It is a method that ought to be particularly adapted to the needs of the physician, and requires no more skill or knowledge of physics than the ordinary practitioner can supply.

Charles L. Norton.
Ralph R. Lawrence.
Rogers Laboratory of Physics, Mass. Inst. Technology,
Boston, February 20.

Semi-Permeable Films and Osmotic Pressure.

Lord Kelvin's very interesting problem concerning molecules which differ only in their power of passing a diaphragm (see Nature for January 21, p. 272), seems only to require for its solution the relation between density and pressure for the fluid at the temperature of the experiment, when this relation for small densities becomes that of an ideal gas; in other cases, a single numerical constant in addition to the relation between density and pressure is sufficient.

This will, perhaps, appear most readily if we imagine each of the vessels A and B connected with a vertical column of the fluid which it contains, these columns extending upwards until the state of an ideal gas is reached. The equilibrium which we suppose to subsist will not be disturbed by communications between the columns at as many levels as we choose, if these communications are always made through the same kind of semi-permeable diaphragm as that which separates the vessels A and B. It will be observed that the difference of level at which any same pressure is found in the two columns is a constant quantity, easily determined in the upper parts (where the fluids are in the ideal gaseous state) as a function of the composition of the fluid in the A-column, and giving at once the height above the vessel A, where in the A-column we find a pressure equal to that in the vessel B.

In fact, we have in either column

$$dp = -g\gamma dz,$$

where the letters denote respectively pressure, force of gravity, density, and vertical elevation. If we set

$$\frac{1}{\gamma} = \mathrm{F}'(p),$$

we have

$$\mathrm{F}'(p)dp = -gdz.$$

Integrating, with a different constant for each column, we get

$$\begin{aligned} \mathrm{F}(p_{\mathrm{A}}) &= -g(z - \mathrm{C}_{\mathrm{A}}) \\ \mathrm{F}(p_{\mathrm{B}}) &= -g(z - \mathrm{C}_{\mathrm{B}}) \\ \mathrm{F}(p_{\mathrm{A}}) - \mathrm{F}(p_{\mathrm{B}}) &= g(\mathrm{C}_{\mathrm{A}} - \mathrm{C}_{\mathrm{B}}). \end{aligned}$$

In the upper regions,

$$\mathrm{F}'(p) = \frac{1}{\gamma} = \frac{at}{p}$$

$$\therefore \quad \mathrm{F}(p) = at \log p,$$

where t denotes temperature, and a the constant of the law of Boyle and Charles. Hence,

$$at \log p_{\mathrm{A}} - at \log p_{\mathrm{B}} = g(\mathrm{C}_{\mathrm{A}} - \mathrm{C}_{\mathrm{B}}).$$

Moreover, if $1 : n$ represents the constant ratio in which the S- and D-molecules are mixed in the A-column, we shall have in the upper regions, where the S-molecules have the same density in the two columns,

$$\gamma_{\mathrm{A}} = (1 + n)\gamma_{\mathrm{B}} \qquad p_{\mathrm{A}} = (1 + n)p_{\mathrm{B}}$$
$$g(\mathrm{C}_{\mathrm{A}} - \mathrm{C}_{\mathrm{B}}) = at \log (1 + n).$$

Therefore, at any height,

$$\mathrm{F}(p_{\mathrm{A}}) - \mathrm{F}(p_{\mathrm{B}}) = at \log (1 + n).$$

This equation gives the required relation between the pressures in A and B and the composition of the fluid in A. It agrees with van 't Hoff's law, for when n is small the equation may be written

$$\mathrm{F}'(p_{\mathrm{A}})(p_{\mathrm{A}} - p_{\mathrm{B}}) = atn$$

or

$$p_{\mathrm{A}} - p_{\mathrm{B}} = atn\gamma_{\mathrm{A}}.$$

But we must not suppose, in any literal sense, that this difference of pressure represents the part of the pressure in A which is exerted by the D-molecules, for that would make the total pressure calculable by the law of Boyle and Charles.

To show that the case is substantially the same, at least for any one temperature, when the fluid is not volatile, we may suppose that we have many kinds of molecules, A, B, C, &c., which are identical in all properties except in regard to passing diaphragms. Let us imagine a row of vertical cylinders or tubes closed at both ends. Let the first contain A-molecules sufficient to give the pressure p' at a certain level. Then let it be connected with the second cylinder through a diaphragm impermeable to B-molecules, freely permeable to all others. Let the second cylinder contain such quantities of A- and B-molecules as to be in equilibrium with the first cylinder, and to have a certain pressure p'' at the level of p' in the first cylinder. At a higher level this second cylinder will have the pressure which we have called p'. There let it be connected with the third cylinder through a diaphragm impermeable to C-molecules, and to them alone. Let this third cylinder contain such quantities of A-, B-, and C-molecules as to be in equilibrium with the

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